REMARKS

Summary

This Amendment is responsive to the final Office Action mailed on May 5, 2004. Claims 1, 4-6, 11, 15, 18-20, and 25 are amended herein. Claims 2, 3, 7-10, 16, 17, and 21-24 are cancelled. Claims 1, 4-6, 11-13, 15, 18-20, 25-27, and 29-32 are pending.

Claims 1, 11-13, 15, and 25-27 stand rejected pursuant to 35 U.S.C. § 103(a) as being unpatentable over Kurogane (US 6,259,424) in view of Krusius (US 6,005,649).

Claims 2, 7-10, 16, and 21-24 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kurogane and Krusius in view of Henley (US 5,459,410).

Claims 29-32 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kurogane, Krusius, and Henley in view of Hiroki (US 6,618,115).

Claims 3-4 and 17-18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kurogane, Krusius, and Henley in view of Yamazaki (US 6,147,667).

Claims 5 and 19 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kurogane, Krusius, and Henley in view of Yang (US 6,392,427).

Claims 6 and 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kurogane, Krusius, Henley, and Yamazaki in view of Anholm (US 5,043,655).

Applicants respectfully traverse the foregoing rejections in view of the amended claims and the following comments.

Discussion of Amended Claims

Claim 1 is amended to include the subject matter of claim 3. Claims 2 and 3 are cancelled to avoid duplication of claimed

subject matter. The preambles of claims 1 and 15 are also amended to specify that defects caused by inoperative pixels are mitigated, rather than repaired, in order to more accurately describe the claimed invention. Since the techniques set forth in Applicants' claims involve connecting an inoperative pixel to the working drive circuit of a nearby pixel, the inoperative pixel will be driven to display the same value as the nearby pixel, which is not necessarily the correct value that would have originally been displayed at that pixel. Therefore, it is more accurate to state that Applicants' claimed techniques mitigate the defects in the display caused by inoperative pixels, rather than completely repair any defects in the display.

Claims 4-6 are amended to depend from claim 1, rather than cancelled claim 3.

Claim 15 is amended to include the subject matter of claim 17. Claims 16 and 17 are cancelled to avoid duplication of claimed subject matter.

Claims 11 and 25 are amended to conform to the changes to claims 1 and 15.

Claims 18-20 are amended to depend from claim 15, rather than cancelled claim 17.

Claims 7-10 and 21-24 are cancelled to avoid claiming inconsistent subject matter.

As a result of the foregoing amendments, Applicants' claims are now directed to techniques for <u>mitigating defects</u> caused by inoperative pixels, which techniques involve the use of a bypass bit latch to connect the inoperative pixel to working drive circuitry of a nearby pixel. The use of such a bypass bit latch comprises a <u>logical switching</u> of the drive circuitry from one pixel to another, rather than physical re-wiring of the pixel drive circuitry. Such techniques involving logical switching as now claimed by Applicants can only be implemented on micro-displays built on micro-circuitry, and are not applicable to

displays which use TFT technology.

Accordingly, the prior art does not show or remotely suggest the techniques claimed by Applicants for mitigating defects that rely on logical switching of the drive circuitry in order to mitigate a defect caused by an inoperative pixel in a micro-display.

Discussion of Prior Art

Applicants' independent claims 1 and 15 now include the subject matter of claims 3 and 17, respectively. Claims 1 and 15 now specify that a bypass bit latch is used to connect the inoperative pixel to a working drive circuit of a nearby pixel, such that when a bypass bit is set, the defective drive circuitry is bypassed and the inoperative pixel is driven from the working drive circuit of a nearby pixel.

The Examiner has rejected claims 3 and 17 based on a combination of Henley, Kurogane, Krusius, and Yamazaki. Applicants' respectfully submit that the present invention as set forth in claims 1 and 15 would not have been obvious to one skilled in the art in view of Henley, Kurogane, Krusius, and Yamazaki.

Henley discloses a method for repairing inoperative pixels by providing redundant TFT drive circuitry for each pixel (Col. 12, lines 13-41). The repair technique of Henley involves physical rewiring or reconnecting of the pixel to redundant drive circuitry. In particular, Henley discloses that the connections between the inoperative TFT drive circuitry are physically severed using laser ablation and a new connective path is formed between the redundant TFT drive circuitry and the pixel using deposition methods (col. 12, lines 28-41).

Kurogane discloses a process for building an LCD display using TFT technology. In Kurogane, the TFTs are tested during the

process of building the display (Col. 16-21). As subsequent masks are applied to build the display, the inoperative pixel is disconnected from its defective drive circuitry and connected to a pixel electrode of an adjacent pixel. For example, a defective transistor 1A is disconnected from the pixel electrode 2A, and the pixel electrode 2A of the inoperative pixel 21 A is electrically connected to the pixel electrode of the adjacent normal pixel 22B during the process of building the display (Col. 9, lines 57-64; Figure 7).

Therefore, Kurogane involves physically rewiring or reconnecting of the pixel drive circuitry during the manufacturing process. In contrast, Applicants' claimed invention involves mitigating the defects caused by an inoperative pixel using logical switching (i.e., a bypass bit latch) to connect the inoperative pixel to a working drive circuit of a nearby pixel. Accordingly, Applicants claimed techniques involve logical switching of the drive circuitry enabled by the use of the bypass bit latch, thereby obviating the need for physical rewiring of the inoperative pixel to working drive circuitry as in Kurogane.

Further, in Kurogane, the TFTs are tested during an early stage of the manufacturing process of the TFT display and the defect is repaired during the next stages of the manufacturing process. In contrast, with Applicants' invention, the inoperative pixel is identified after fabrication of the CMOS control chip, requiring that the defect mitigation techniques claimed by Applicants are also carried out after fabrication.

Krusius discloses methods for constructing a large flat-panel display from an array of micro-displays having CMOS circuitry. Krusius does not disclose or remotely suggest any strategies for pixel repair or mitigation of defects caused by inoperative pixels.

The Examiner has acknowledged that Henley, Kurogane, and Krusius do not disclose the use of a bypass bit latch to connect

an inoperative pixel to working drive circuitry of a nearby pixel, as claimed by Applicants.

The Examiner relies on Yamazaki as disclosing the use of bit latch circuitry. Yamazaki discloses an active matrix display built using TFT technology. Latch circuitry is used in the source line driver circuit 103 (Col. 23, lines 10-15; Figures 12A-12C). Yamazaki <u>does not disclose or remotely suggest any strategies for pixel repair or mitigation of defects caused by inoperative pixels</u>. In particular, Yamazaki does not disclose or suggest using a bypass bit latch to connect an inoperative pixel to a working drive circuit of a nearby pixel, as claimed by Applicants.

The present invention relates to mitigation of defects caused by inoperative pixels in a micro-display having <u>CMOS drive circuitry</u>. With the present invention, logical switching of the drive circuitry for the inoperative pixel is accomplished using a bypass bit latch so that physical rewiring of the inoperative pixel to a working drive circuit is not required.

As discussed above, Henley and Kurogane disclose repair technologies involving <u>physical rewiring</u> of the inoperative pixel to a working drive. The Examiner has acknowledged that Henley, Kurogane, and Krusius do not disclose the use of a bypass bit latch for connecting the inoperative pixel to a working drive circuit as claimed by Applicants. Krusius and Yamazaki do not disclose any techniques for repairing inoperative pixels or mitigating defects caused thereby.

Applicants respectfully submit that it would not have been obvious to one skilled in the art to combine the disclosures of Kurogane, Henley, Krusius, and Yamazaki as suggested by the Examiner and to arrive at Applicants' invention from such a combination.

In particular, in the art of micro-circuitry, the concept of a "repair" is limited to one that restores <u>perfect</u> logic

functionality (i.e., a repaired memory cell would have to be able to continue to store differing values independent of its neighbors). The prior art concerning repair of micro-circuitry comes from the use of micro-circuitry in logic circuits. In such cases, the device is only useful if it functions <u>perfectly</u> from a logic point of view. Thus, prior art repair techniques for micro-circuitry tend to be related to fully and perfectly restoring the logic function. This often requires fully redundant circuits (e.g., as an extra row in the memory array) to be switched in.

Also, in the art of logic circuitry, the physical location of where the logic computation occurs is unimportant. In a typical logic circuit design, the signals are routed on buses that go past every logic cell. These buses are time-shared such that the output of only a small percentage of the logic cells are ever being transmitted at any given time. It is easy to add a few extra logic cells connected to the same bus without any substantial difficulty in routing the signals; simply extend the bus wires across a couple of redundant rows of logic cells at the end of the array.

A non-display micro-circuit may have the same or similar amounts of logic cells as a micro-display has pixel drive circuits. However, due to the time sharing of the buses, the logic in a non-display micro-circuit is never read with all bits (e.g., 8-12 million bits) appearing at output electrodes simultaneously. However, when combining the art of micro-integrated circuits with a display, it becomes important that the repaired or replaced logic function is <u>proximal to the location of the inoperative pixel</u>. The location where the pixel drive circuit is located is necessarily proximal to the actual pixel electrode because there are so many pixels in the display. Because the output of every pixel drive circuit needs to be continuously driving their respective pixels at all times, to route the output of each pixel drive circuit to the desired pixel

electrode requires one wire per pixel. Micro-circuits have a limited number of interconnect layers (a handful, up to maybe a dozen) to carry signals. To imagine routing millions of signals on a handful of routing layers in any complex fashion other than directly to a proximal pixel electrode quickly becomes intractable as the complexity of the redundant circuit configuration goes up. In a typical micro-display, the pixel electrode is directly on top of the drive circuitry, built out of the top layer of interconnect metal and the "wire" is a via directly down to the final output transistor in the pixel drive logic cell.

As many of the repair techniques in the art of micro-circuitry do not preserve the physical location of the function, these prior art repair techniques are unsuitable for micro-displays. Because of the massively parallel connections between the drive circuit for each of millions of pixels and the millions of pixel electrodes, there are intractable difficulties in making provisions for routing signals from a small number of redundant drive circuits to any possible set of pixels that may be defective. Using fully redundant circuitry as is done in the art of repairing micro-circuits would necessarily result in an implementation having redundant circuits for each pixel, or perhaps in small clusters of pixels, which is not feasible with micro-displays.

Further, in contrast to such "perfect" repair techniques, with Applicants' invention, defects caused by inoperative pixels in a display are mitigated by connecting an inoperative pixel to the drive circuitry of a nearby pixel. In other words, with Applicants' invention, after defect mitigation, the inoperative pixel and the nearby pixel will display the same value from the same drive circuit. Thus, with Applicants' claimed invention, the display is not "perfectly" repaired.

For many applications of displays, mitigating defects caused

by inoperative pixels by having some pixels tied together to the same drive circuitry so that they display the same value here and there across the area of the display is not objectionable. In practice such mitigated defects are imperceptible. Accordingly, the mitigation techniques claimed by Applicants yield a useful display even if every pixel is not "perfectly" repaired using redundant drive circuitry.

The present invention is clearly a distinct departure from Henley, Kurogane, and other similar prior art. The present invention can be used to turn an otherwise unusable display into a display that functions adequately for the application without necessarily being perfectly repaired. Applicants' mitigation techniques provide a usable display without the disadvantages of adding completely redundant drive circuits as required by Henley, or by physically rewiring or reconnecting the pixels to either redundant or nearby drive circuitry, as disclosed in Henley and Kurogane.

Henley does not disclose or remotely suggest mitigating a defect in a display caused by an inoperative pixel by connecting an inoperative pixel to the working drive circuitry of a nearby pixel, as set forth in Applicants' claims. Since Henley provides redundant drive circuitry, the repaired pixel will display its originally intended value. Therefore, Henley provides a complete and perfect repair of the display. However, Henley has the disadvantage of using a completely redundant drive circuit for every pixel.

Further, although Kurogane discloses connecting an inoperative pixel to working drive circuitry of an adjacent pixel, Kurogane clearly indicates that, for purposes of its disclosure, the term "adjacent pixel" implies pixels of the same color (Col. 6, lines 47-56). By connecting the inoperative pixel to the drive circuit of an adjacent pixel displaying the same color, the repaired pixel will display its originally intended

value. Therefore, Kurogane, like Henley, is intended to provide a complete and perfect repair of the display.

In order for the present invention to be considered obvious in view of the prior art combination relied on by the Examiner, one skilled in the art would have to:

(1) go from the art of TFT displays (as disclosed in Henley and Kurogane) to the art of micro-displays;

(2) go from the art of repair through the use of redundant circuitry (Henley) and physical re-wiring (Henley and Kurogane) to the art of repair through logical switching;

(3) while at the same time discarding the traditional notions of micro-logic-circuits which would lead one skilled in the art to conclude that perfect logic functionality needs to be restored by the repair;

(4) while also realizing:

(a) that the correct physical relationship to the driven pixel must be maintained and then solve the difficulty in routing the redundant signals to the correct pixels; and

(b) that the additional area consumed by the bit-latch and switching circuitry for each pixel is less than that consumed by fully redundant drive circuitry for each pixel.

The cited prior art provides no motivation or teachings for making these mental leaps from one technology to another to arrive at Applicants' invention as would be required by the Examiner's combination of disparate technologies.

One skilled in the art would appreciate that the art of repairing TFT displays is substantially different that that of repairing micro-displays, due to the substantial differences in the display technologies themselves. The chart below illustrates some important differences between TFT displays and micro-displays:

PARAMETER	TFT LCD's	LCOS (LCD on Silicon) Micro-Displays
Display Size	25mm (watch face) 1.5 meters (large tv screen)	5mm to 50mm (IC chip fab limited)
Typical Pixel Size	0.15 to 1.0mm	0.003mm to 0.015mm
Minimum Circuitry Feature Size	10 um ?	0.25 um (0.06um nowadays)
Transistors per pixel	1 typical, 2 to 5 max.	10's typical, 100-200 possible.
Total Transistors	10 million	100's of millions, to over 1 Billion.
Max Clock Rates	Tens of Mhz	Over 1 Ghz
Substrate	Glass (possibly amorphous-silicon coated).	I.C. grade, single-crystal, silicon wafer.
Typical Application	Direct View	Magnified or projected view
Viewing Configuration	Transmissive using thin-film-transistors and conductors	Reflective only due to metal conductors.
Mask tooling costs (per layer)	$1000's	$100,000's

For example, the logical switching techniques claimed by Applicants involving the use of a bypass bit latch to connect the inoperative pixel to the working drive circuitry of a nearby pixel is unworkable in the TFT displays of Henley and Kurogane. TFT Displays typically have enough room for only one or two transistors and three addressing wires per pixel, it is not possible to implement the logic switching techniques claimed by Applicants due to the limited amount of logic circuitry that can fit in the space of each pixel. Accordingly, the techniques claimed by Applicants cannot simply be transferred to TFT display technology, and *vice versa*.

Only with hindsight gained impermissibly from Applicants' disclosure could one of ordinary skill in the art have possibly arrived at the claimed invention from the combination of Kurogane, Henley, Krusius, and Yamazaki. Moreover, there are no detailed teachings in any of these prior art references that would have motivated or enabled one skilled in the art to combine them as suggested by the Examiner.

To combine Henley and Kurogane to arrive at the present invention would require that the disadvantages of using redundant circuitry of Henley be removed, in addition to overcoming the

preliminary detection and repair process required by Kurogane. Neither reference teaches how to overcome these issues. Further, one skilled in the art would not be motivated to look to combine the teachings of Krusius and or Yamazaki with that of Henley and Kurogane, since neither Krusius nor Yamazaki discloses any repair or mitigation strategy.

Therefore, the combination of Kurogane, Henley, Krusius, and Yamazaki taken as described (and in the absence of the teachings of the present invention) is insufficient to result in the functionality embodied by the present invention without further creative thought.

Further, Applicants respectfully submit that a combination of Henley, Kurogane, Krusius, and Yamazaki would not result in the invention described in Applicants' amended claims. None of the cited references discloses mitigating defects caused by inoperative pixels in a liquid crystal micro-display that is built on a silicon integrated circuit substrate having an integral CMOS control chip, wherein a bypass bit latch is used to connect the inoperative pixel to a working drive circuit of a nearby pixel after fabrication of the CMOS control chip.

Applicants respectfully submit that the present invention would not have been obvious to one skilled in the art in view of the combination of Henley, Kurogane, Krusius, and Yamazaki, or any of the other prior art of record.

Further remarks regarding the asserted relationship between Applicants' claims and the prior art are not deemed necessary, in view of the amended claims and the above discussion. Applicants' silence as to any of the Examiner's comments is not indicative of an acquiescence to the stated grounds of rejection.

Conclusion

In view of the above, the Examiner is respectfully requested to reconsider this application, allow each of the presently pending claims, and to pass this application on to an early issue. If there are any remaining issues that need to be addressed in order to place this application into condition for allowance, the Examiner is requested to telephone Applicants' undersigned attorney.

Respectfully submitted,

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